THE MANUFACTURE OF PORTLAND CEMENT

With the Compliments of the

KANDOS CEMENT COMPANY LIMITED

Kandos Cement Company Limited

Nominal Capital £1,000,000

Paid-up Capital as at 1st March, 1924: £842,328

Directors:

ALBYN A. STEWART, Esq., Chairman.

Hon. G. R. W. McDONALD, M.L.C. COLIN E. D. ROGERS, Esq.

C. A. JAQUES, Esq.

HUNTER WHITE, Esq. A. COPELAND, Esq.

General Manager: F. P. KNEESHAW, M.I.E. (Aust.)

Works Manager: H. SCHRODER.

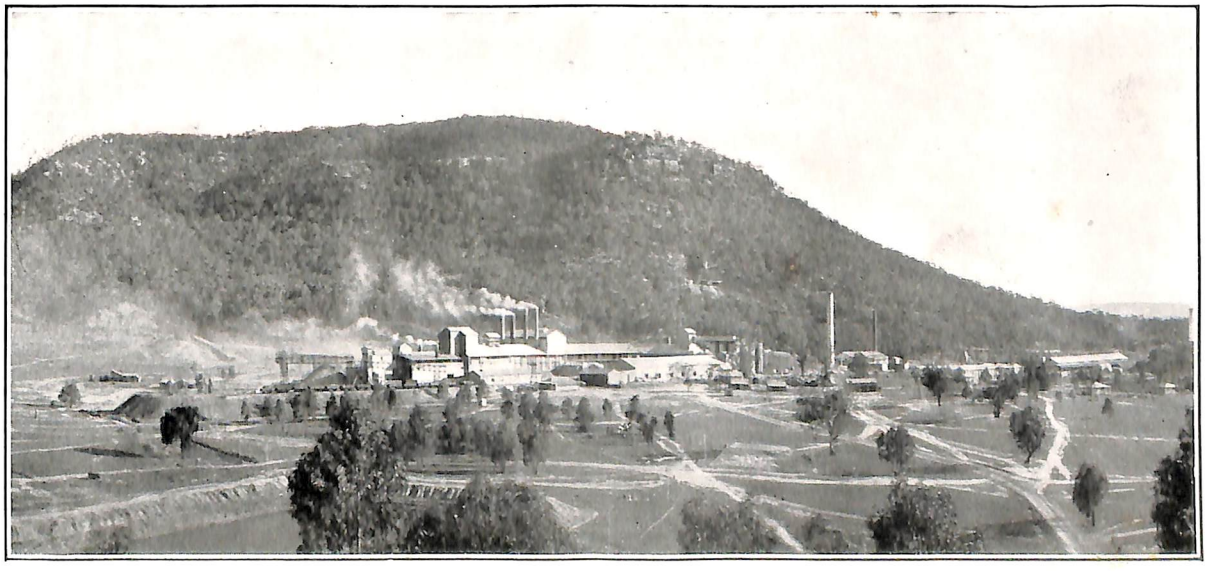
Secretary: C. C. CAMPBELL. Works, Kandos, N.S.W.

Registered Office: 39 Hunter Street, Sydney.

Telephones: B 6741, B 6742.

Telegraphic and Cable Address: "KANDOE, Sydney."

1st March, 1924.



General View of the Kandos Cement Company's Works.

An All-Australian Company

The Kandos Cement Company is all Australian, the whole of the capital being subscribed in Australia.

The Manufacture of Cement

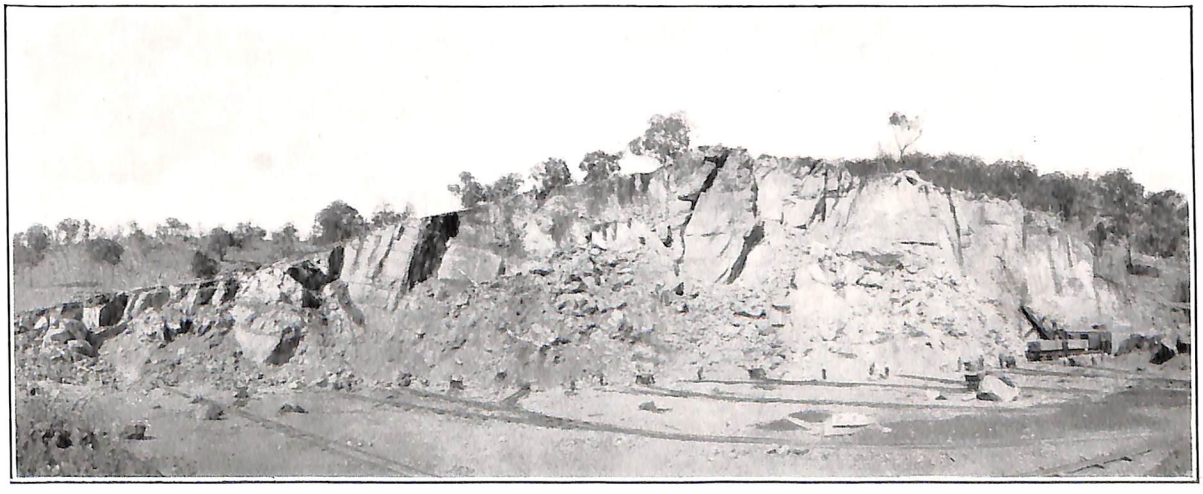
by the

Kandos Cement Company Limited.

GENERAL

Every age in human history has been marked by some characteristic development in the materials of construction or use, and these materials have given a name to each era, constituting both an index to human civilisation and a milestone on the path of Progress. Present tendencies in the constructional world, and the properties of the material itself, are prophetic of a universal increasing employment of CONCRETE, and of the dawn of a new period in the above chronology; the CONCRETE AGE, legitimate successor to the Ages of STEEL, of IRON, of BRONZE, and of STONE.

Concrete is as yet only half discovered. The composition of Cement, and the mechanism of its reactions, are still speculative, but its possibilities are increasingly evident and increasingly appreciated. Concrete is by far the most flexible, serviceable, and simple of construction media, and derived from raw materials more generally available than those of any other product of such importance to industry, it will become in Australia what it is abroad, the keynote of constructional policy in Buildings, Engineering Structures, and Roads. In this sense, and in view of the influence which Concrete already exerts in Australian Engineering Practice, the question of sources and production of Cement becomes one of national importance.



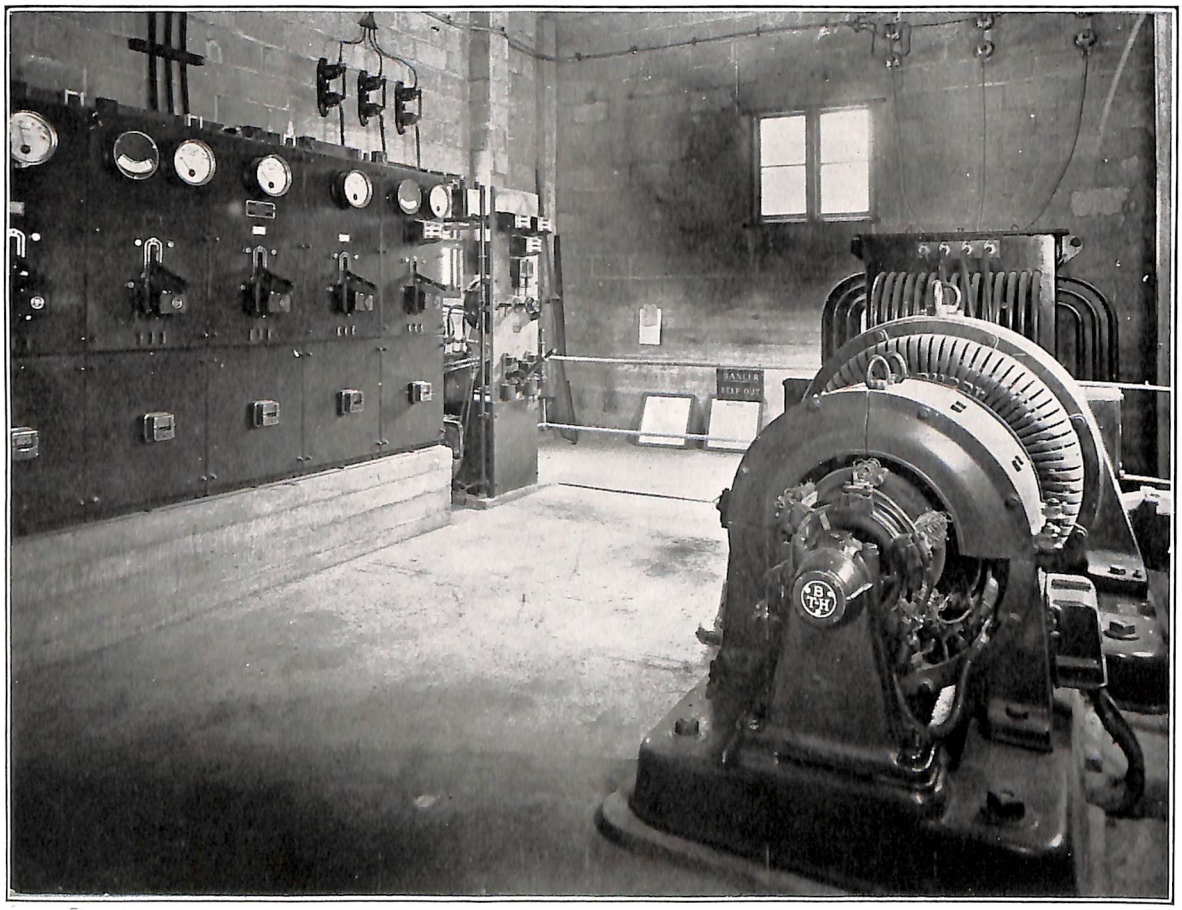
Panoramic View of Limestone Quarry.

A consideration, therefore, of a typically modern plant, such as that of the Kandos Cement Company, has more than passing interest. This Company has framed its production policy on the soundest lines, in the selection of staff, in the balancing of processes, in the thoroughness of methods, and in the arrangements for the efficient handling of large outputs.

LOCATION

A town of 2500 inhabitants surrounds the Company's works at Kandos, N.S.W., situated on the railway line to Mudgee, in a depression below the local Hawkesbury sandstone horizon, and here the process up to the finished product is carried out completely, raw materials and coal being within easy haulage distance.

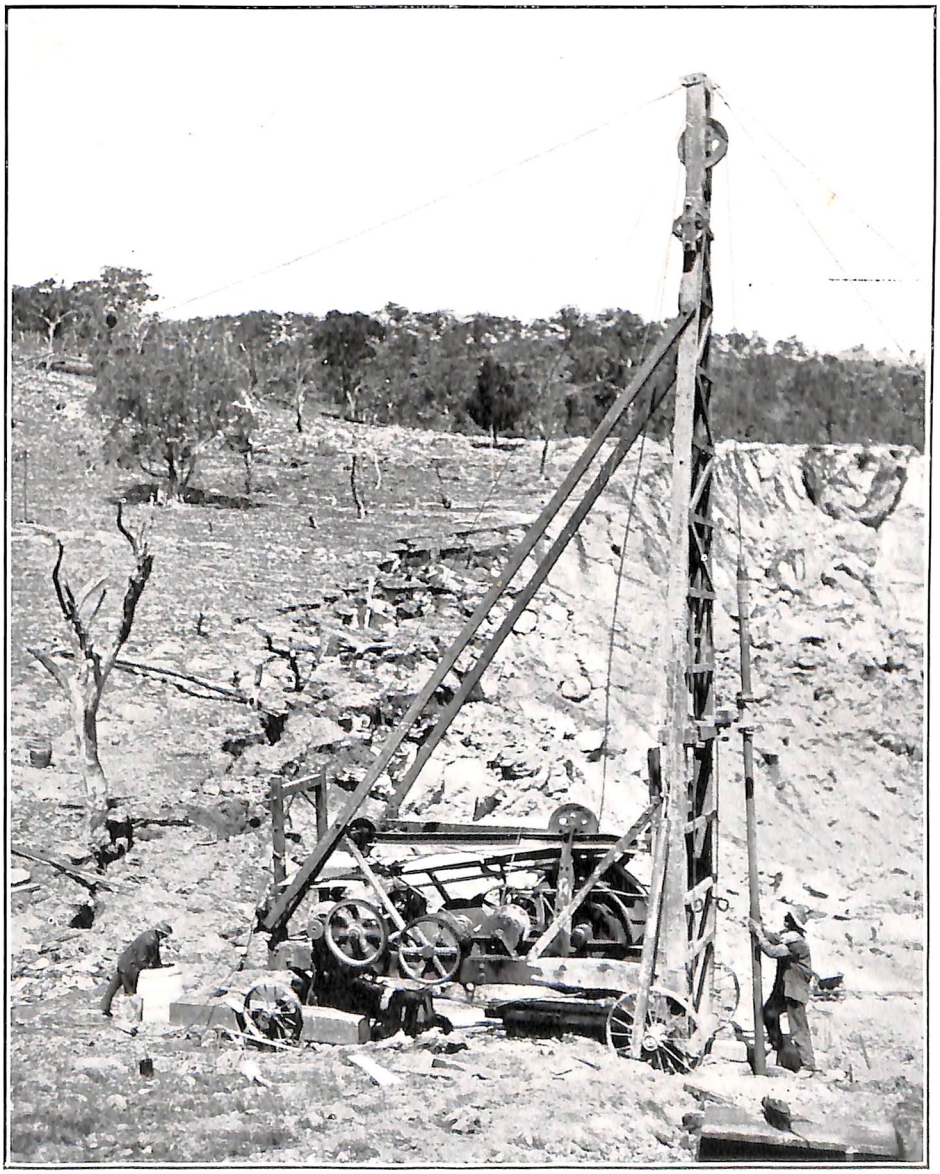
Portland Cement is a British invention, having been originally patented in 1824 by Joseph Aspdin, of Leeds. It was called "Portland" Cement by the inventor, because of its resemblance, when set hard, to the stone quarried from the cliffs of Portland, England, from which St. Paul's Cathedral, London, and other notable structures have been built.



Interior of Electric Sub-station from which power is distributed to Quarry.

PRODUCT

This product, PORTLAND CEMENT, is a synthetic compound, which is now considered to be a solid chemical solution of Tricalcium Silicate ($3Ca\ O.Si\ O_2$) Dicalcium Silicate ($2Ca\ O.Si\ O_2$), and an uncertain Aluminate of Calcium. The only raw materials used are Limstone (which is chiefly Calcium Carbonate) and Shale (Silicate of Alumina), the properties of these in the raw mixture varying with their respective purity. Attention is first naturally directed to the methods of quarrying the Limestone and Shale, and since these methods have an influence on the final cost, which is highly important, but frequently overlooked, the Kandos way deserves particular notice, as an honest attempt to handle a large output in the most modern and efficient manner.



The Churn Drill.

QUARRYING

The Limestone Quarry illustrated lies about three miles approximately west of the town and works, to which latter it is connected by Aerial Ropeways.

QUARRY POWER

Electric Power in the Quarry is distributed from a neat Sub-station, which is connected to the Works Power House by duplicate 5000 volt A.C. Transmission Lines. In the Sub-station a synchronous motor generator (which is now being duplicated) transforms a portion of the supply to 250 volts D.C., in which form it is fed to the locomotives. Duplicate three-phase Transformers step down the balance of the supply to 440 volts A.C., at which pressure the other Units are operated.

This arrangement as a whole possesses all the advantages attaching to electrical operation, as well as highly satisfactory power factor conditions.

SHOOTING

Stone containing an average of 90 per cent. calcium carbonate is shot from a semi-circular face, varying up to 150 feet in height from the floor of the Quarry. The face, which has a length of 1500 feet, is uniformly clean and safe, with practically no overburden, and the

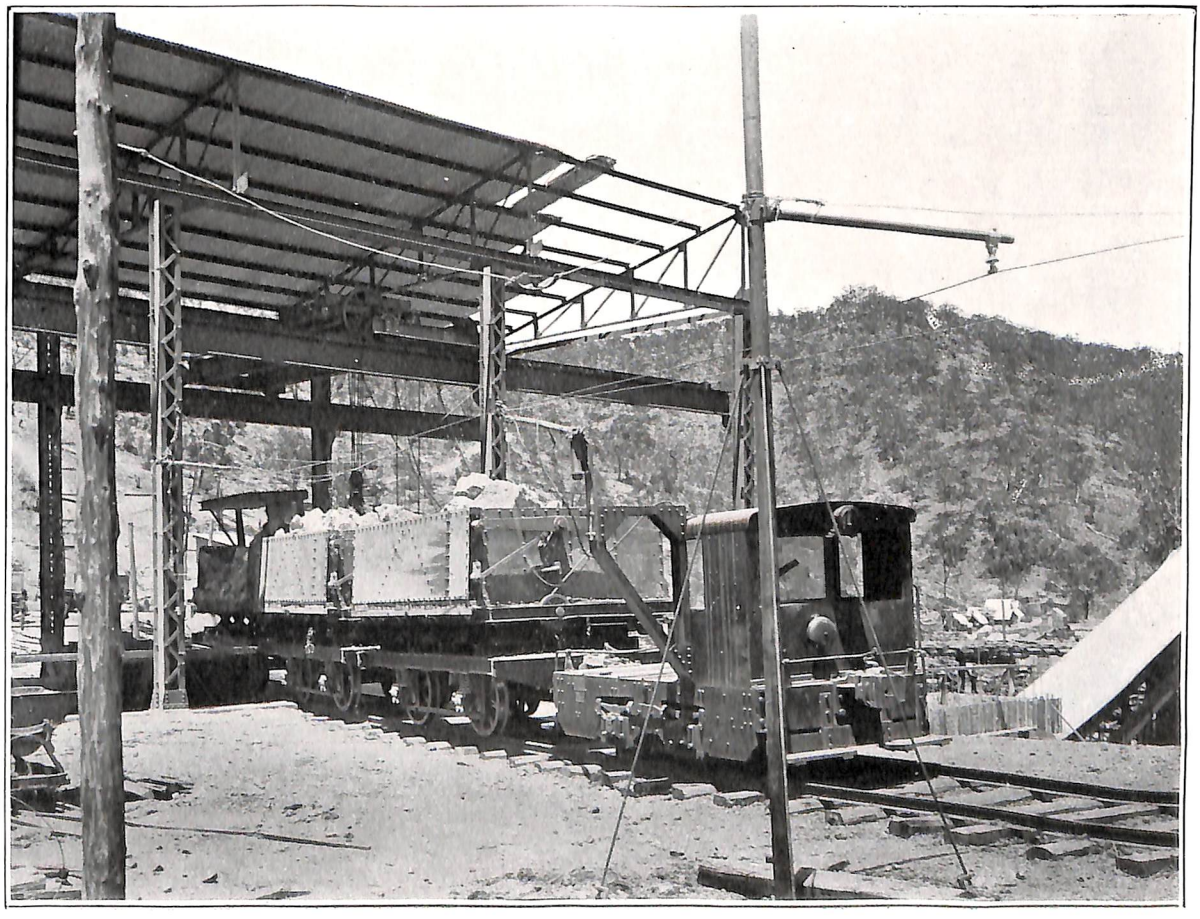
Electric Power Shovel.

usual practice is to fire sets of six or more vertical holes drilled the full depth of the face by a churn drill, in conjunction with shorter holes into the toe, whereby this portion is blown clear immediately before the mass of rock falls, thus facilitating loading operations.

HANDLING

Handling is divided between gangs of men with three-quarter yard side dipping skips and a two and a half yard electric Power Shovel. The latter, which is an entirely self-contained unit, moves under electric power on three sets of caterpillars (the rear one of which swivels for steering) and rapidly fills twelve yard trucks, which are drawn within range on a standard 4ft. 8½in. gauge track by electric locomotives. The shovel is considered an excellent investment, and handles up to 700 tons in the eight-hour shift. Another shovel, three sizes larger than the present one, is now on order.

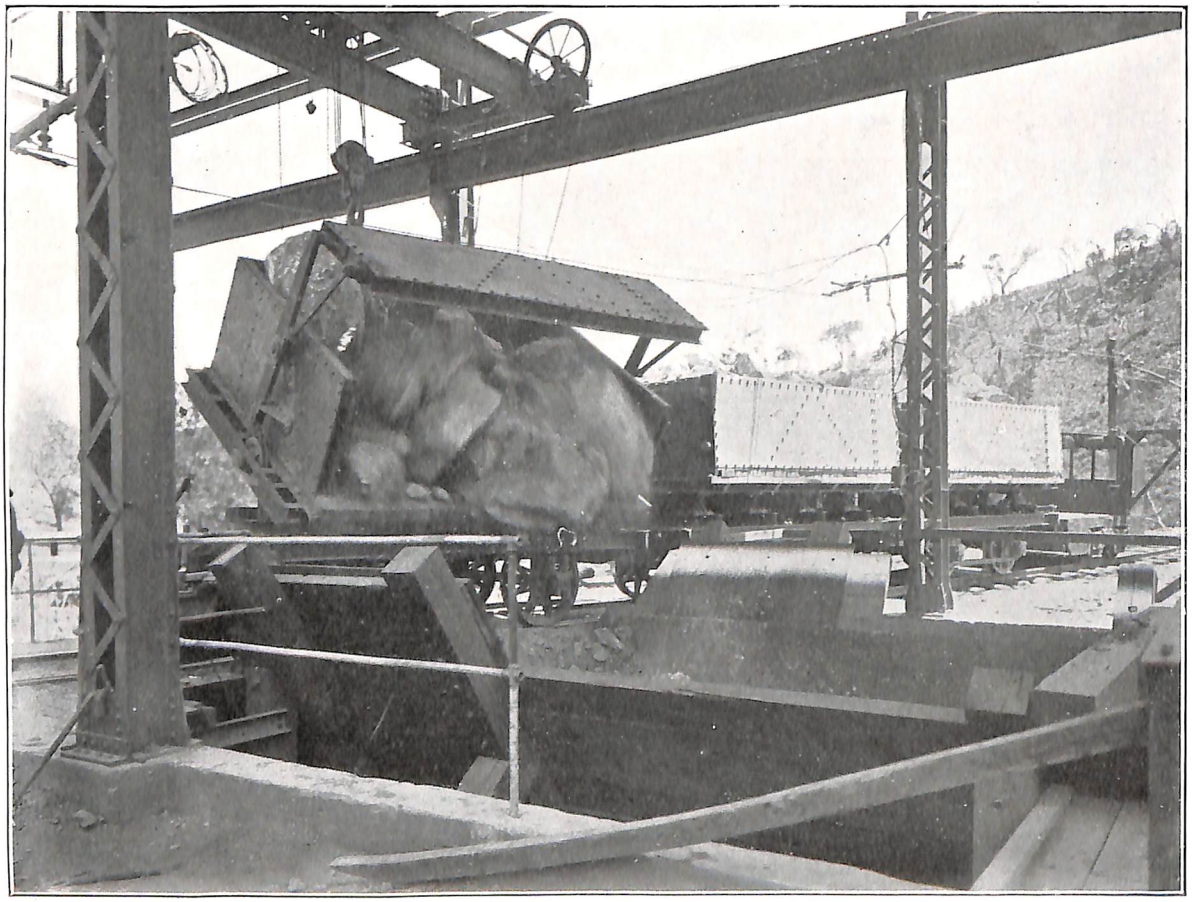
Two Rakes of three trucks each pass continuously between the Shovel and the Crusher House. This part of the handling system could hardly be improved upon for speed, simplicity, and output.



View of Train.

LOCOS & TRUCKS

Special notice is due to the locomotives and trucks which compose the trains. The locos. are fitted with automatic couplings, electric and hand brakes, sand boxes and headlight, and take power from a trolley wire, overhead and to one side of the track, admitting of rapid relocation as the face recedes. The twelve yard trucks were built to the specification of the Company, and combine the necessary sturdiness and long life with automatic operation. The last is secured by the tipping device, which is operated by an overhead travelling crane in the crusher house. The crane hook engages a wire rope along the side of the truck remote from the crusher, which rope opens the side doors and tips the truck, the former operation being complete before the latter commences. It follows that the doors, being clear of the falling stone, are not subject to the battering and abrasion which is usually their portion, and this, combined with ample strength, ensures long service.



Tipping Stone from Trucks into Feeder Apron.

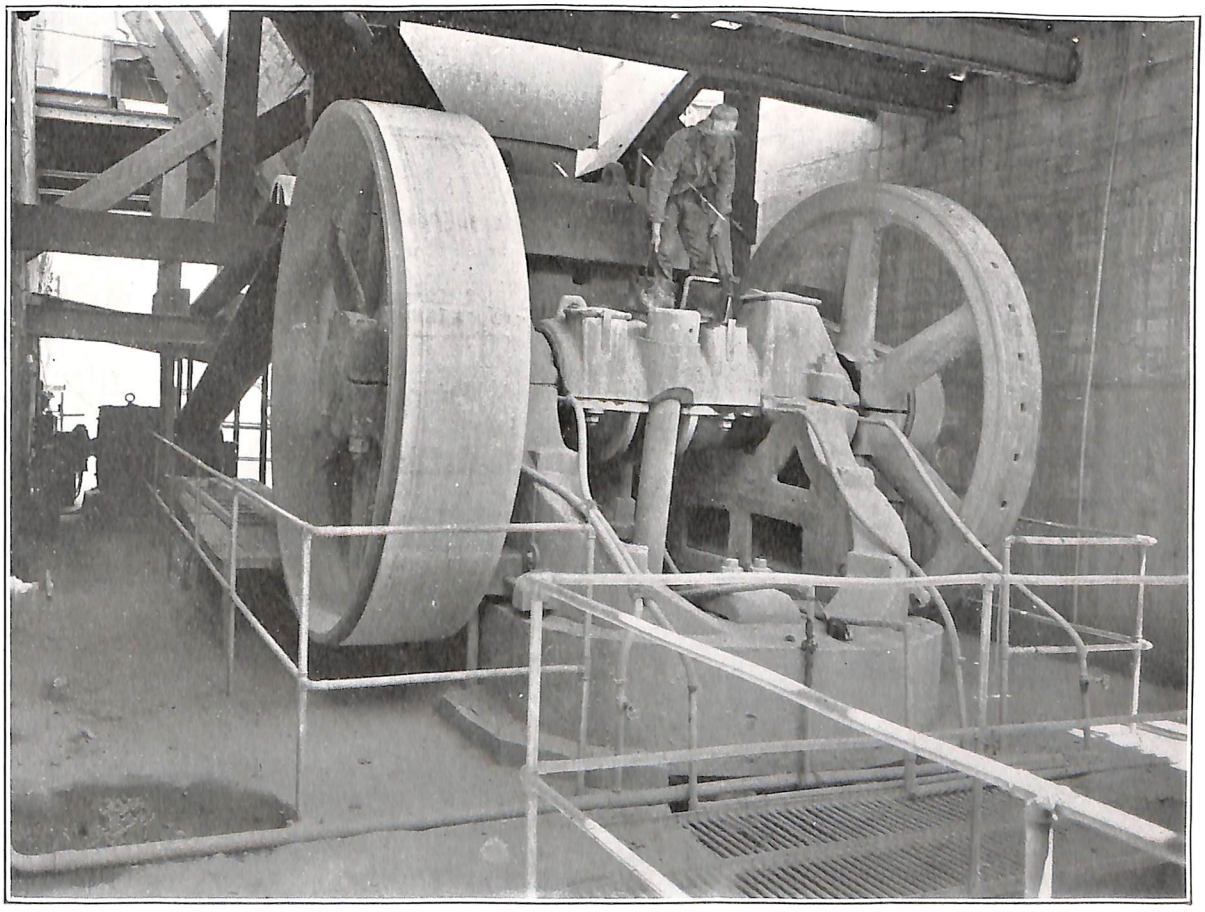
The tipping process is carried out under shelter in the crusher house, a substantial steel structure, with an electric travelling crane referred to above, which is hand traversed when necessary. Stone from the trucks falls upon a feeder apron 5 feet wide, of cast steel plates, which is driven from the crusher shaft through friction gear at about 16 feet per minute.

CRUSHER

The apron delivers to the huge 5 feet by 4 feet Crusher, as do also the hand-tipped skips, direct. This monster weighs 150 tons, and in biting into the rock with its 18 ton swinging jaw, takes 200 H.P. from its motor. It is at this time quite the biggest crusher in Australia, is of American manufacture (Traylor), and delivers to the conveyor 250 tons of limestone per hour, crushed to 6 inch gauge, or 578 tons per hour to 9 inch gauge.

The crushed stone is further reduced in a Pulverising Mill at the end of the first conveyor flight, and from here is carried by another inclined 36 inch conveyor belt to the bins at the terminal loading station of the Aerial Ropeways. Weather protection is continuous, the bins being totally enclosed to prevent loss of wind-blown particles.

Briefly, the Kandos Quarry is a model of efficiency and completeness, and the virtually inexhaustible supplies of limestone available, provide great scope for economical operation.



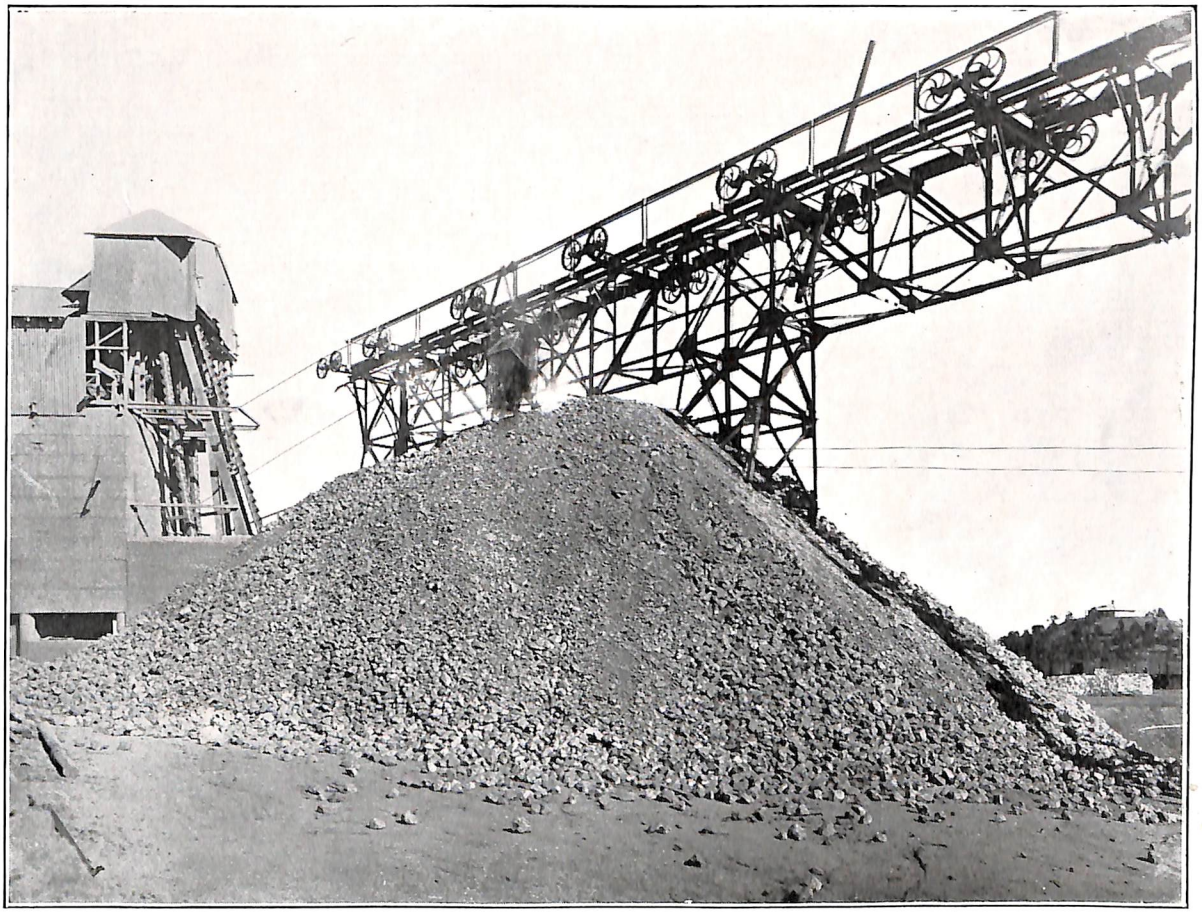
View of Stone Crusher.

ROPEWAYS

Two Aerial Ropeways connect the Quarry Bins to the Works three miles distant, constituting one of the largest systems of its kind in the Southern Hemisphere, and carrying skips each containing one ton of stone over spans up to 600 feet, to be tipped over the conveyor tunnel at the Works terminal. In continuous operation the later Ropeway delivers 120 tons per hour, and the older one 40 tons per hour, now being increased to 80. They are driven through crown and bevel gearing by electric motors at the Works, though

The Loading Stations.

relatively little power is absorbed during actual running. Skips are tipped over the tunnel above referred to, in which runs a conveyor belt, feeding gyratory crushers (later to be dispensed with in favour of pulverising at the Quarry): from these stone at a maximum of 2 inch gauge is mechanically elevated to the mechanical weigher. Provision has been made for a stock of 100,000 tons of stone at the Works.



Aerial Ropeway Terminal Gantry at Works.

The Manufacturing Process.

SHALE QUARRY

At this point the other raw constituent, Shale, is mixed with the crushed Limestone, in proportions which are determined by the impurity of the Limestone, from tests at frequent intervals.

General View of the Shale Quarry.

The source of the Shale is a quarry quite close to this end of the Works, from which it is at present taken in horse-drawn carts, the output required being but a fraction of the Limestone, but plans are now in hand for a mechanical plant for this Quarry.

DRYING

The mixture, after passing through the weigher in batches, is conveyed on belts to two Rotary Driers, where it is dried with furnace gas. The Driers are very similar in appearance and principle to Kilns, being cylinders with axes slightly inclined to the horizontal in the direction of motion of the raw material, rotating and exposing the moving mixture to the heat of the gas by means of iron lifters.

Each Drier delivers 800 tons of raw mixture per shift to the mechanical bucket conveyors, in which it is taken direct to the hoppers of the four Fine Grinding Mills. These Combination Mills grind down the mixture till 90 per cent. will pass through a screen with 40,000 meshes to the square inch, at the rate of 500 tons per shift. As in the finishing Mills the grinding is done in several stages, first with large forged steel balls, and then with cast alloy balls.

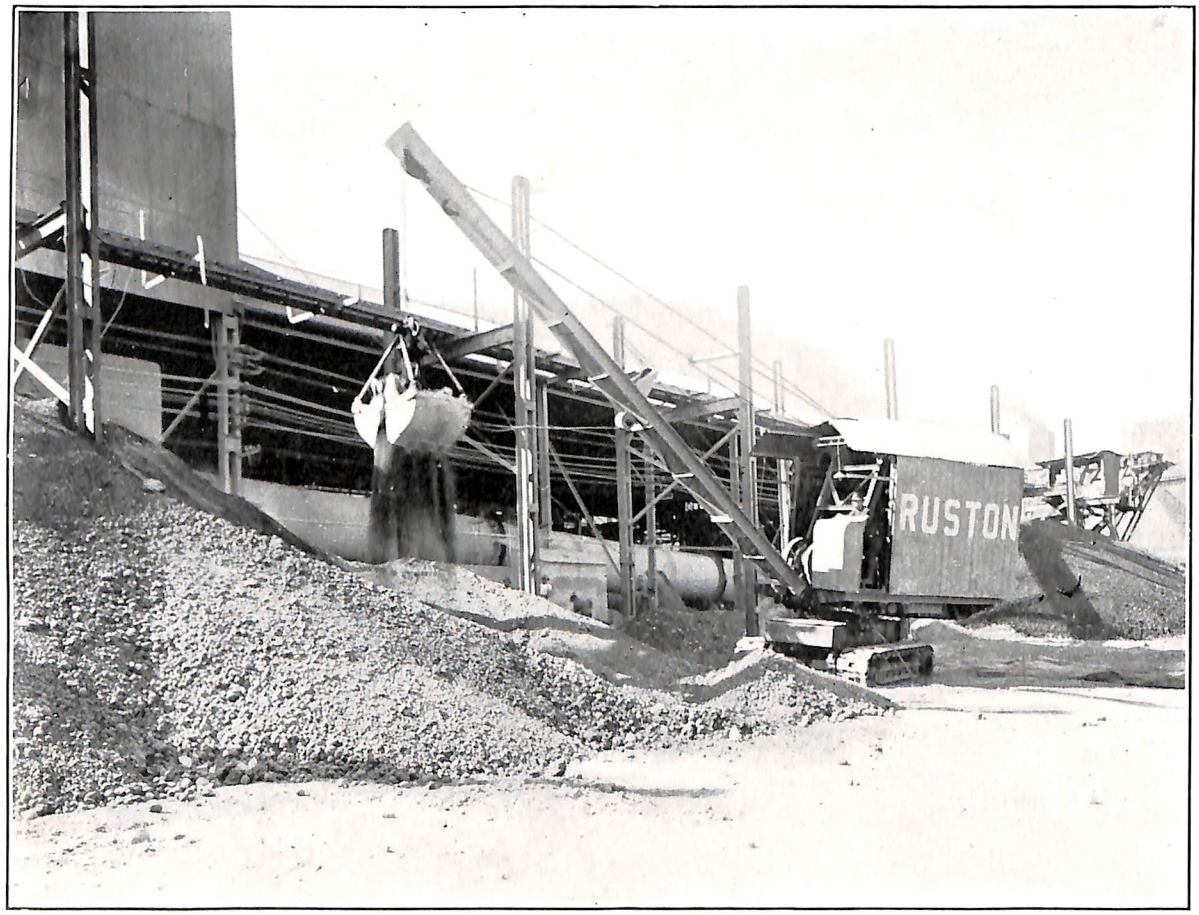
The Kilns.

KILNS

The raw mixture is now ready for the Kilns and is delivered to storage to be fed to four Kilns, where the most important phase of the process is carried out. The Kandos principle has been to arrange all other processes to supply a margin to the Kilns, thus constituting this stage as the determining factor in production. That is to say, the Kiln output, being sensibly the minimum output of all stages, governs the entire production and gives a well-defined control of operation. The Kilns being functionally the most vital units, it has seemed logical to adopt this principle in preference to permitting any other point or points in the series to define the permissible maximum output.

Of the four Kilns, three are 8 feet and one 9 feet in internal diameter. A fifth Kiln of 9 feet diameter is now on order. All are 140 feet in length, in the form of long steel plate cylinders inclined to the horizontal, and supported on two circumferential tyres, each about 30 feet from an end, bearing on two pairs of rollers in cradles.

At the tyre near the entry or upper end, two thrust rollers, one each side, prevent longitudinal play. The Kilns are driven at approximately ½ R.P.M. by independent variable speed motors through gearing to teeth cast on a peripheral wheel near the entry end, and deliver about 500 tons of clinker per day.



The Clinker Crane.

At the lower or exit end of the Kiln a nozzle fitted axially introduces pulverised coal and air at about ½in. of water pressure, which ignites in the kiln, passing as gas against the direction of motion of the incoming raw materials, and causing chemical re-distribution which results in a hard clinker, delivered from a trap at the lower end, to a bucket elevator.

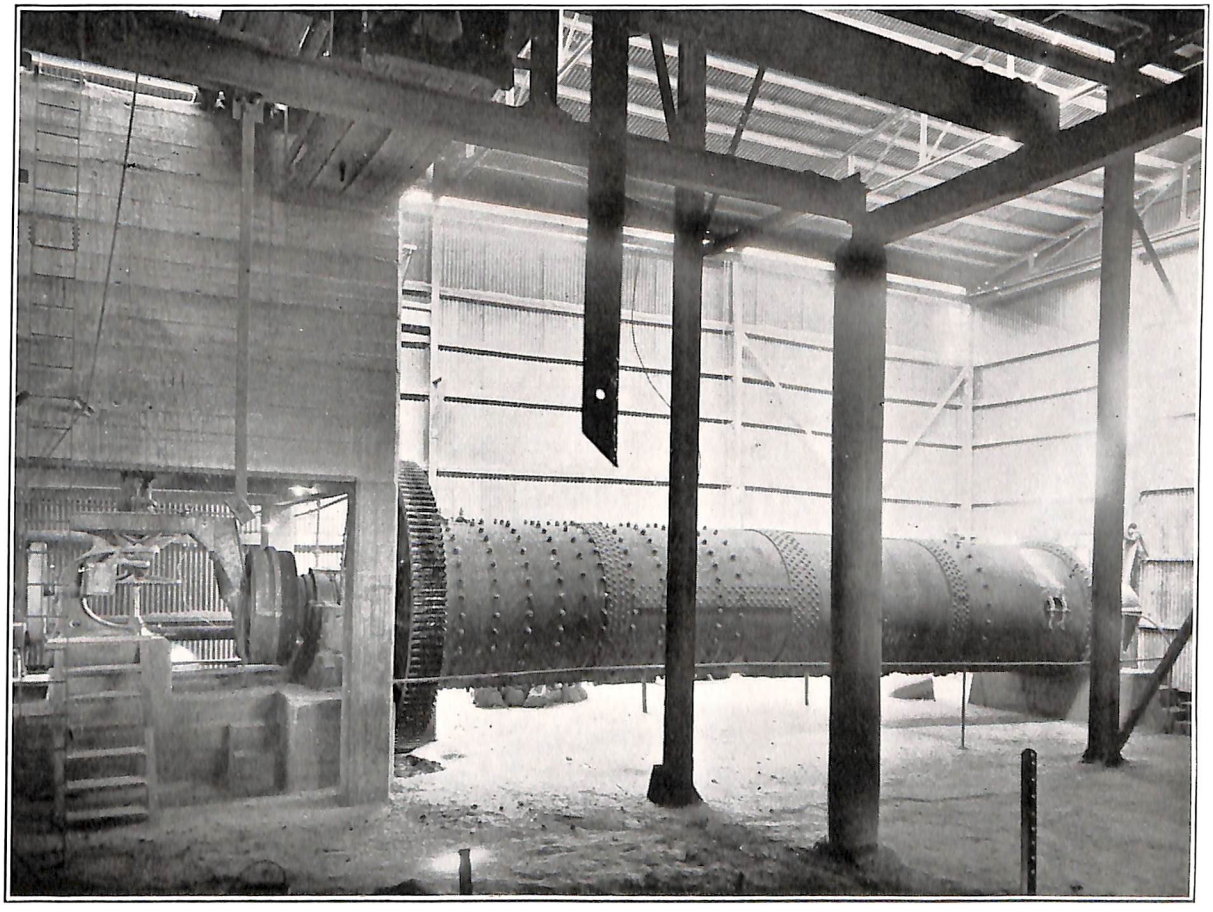
The Kiln is, of course, fire-brick lined, especial care being necessary in the initial hot zone

where a temperature of 2000-2500 Fahrenheit exists for about 30 feet along the Kiln, and where periodical replacements of the lining are necessary.

Two screw extractors feed the pulverised coal from the bins opposite each Kiln, the speed of feed being adjustable through a variable gearing, and admit it to the air blast, with which it enters the Kiln.

CLINKER

The Clinker bucket conveyor tips the still hot clinker in a heap over a conveyor belt tunnel, through which it is transported to the final process. A Ruston Grab Crane is employed to trim the clinker pile, where provision is made for the storage of 40,000 tons of clinker.



The Cement Mill.

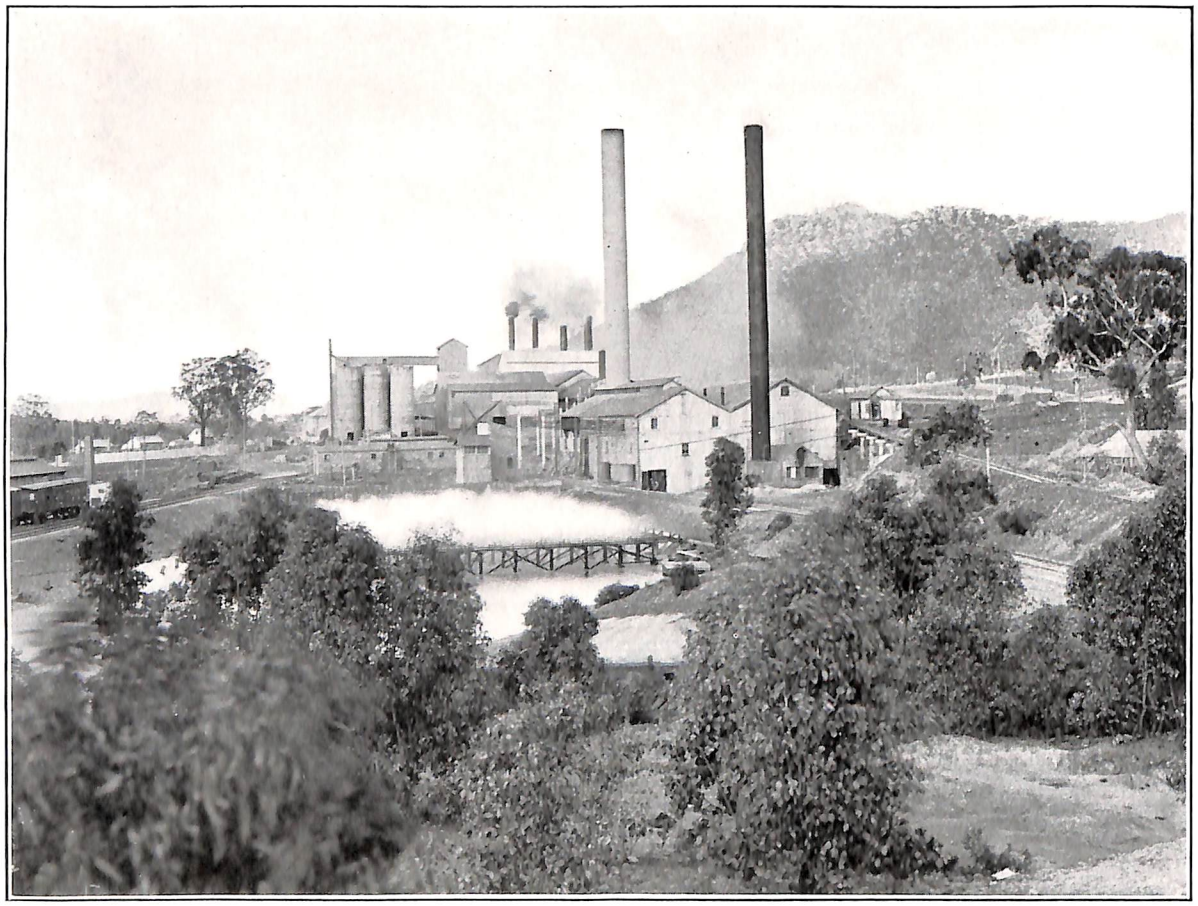
CEMENT MILLS

During its passage from beneath the pile about 2½ per cent. of Gypsum is added to the clinker to retard (i.e. to regulate) the setting time, following which it passes to the Fine Grinding Mills, whence it emerges in its marketable form as fine Cement, 90 per cent. of which will pass through a 32,400 mesh screen. The two Fine Grinding Mills will shortly be supplemented by a third, and are absolutely the latest of their type—the Combination Mill.

POWER HOUSE

Power generation at Kandos is characterised by the same thoroughness and efficiency as the other phases of production which constitutes a tradition unusual in Australian manufactories for the treatment of raw materials. It is particularly encouraging to find the auxiliary contributaries to output, housed and handled in a manner which their importance really justifies in the highest degree, but which is seldom their portion.

The Kandos 4500 K.W. Power House burns its coal in four Babcock & Wilcox Boilers with Chain Grate Stokers, under the watchful eye of a "Mono" Carbon Dioxide Recorder. This instrument evaluates combustible gases in terms of Carbon Dioxide, utilising the



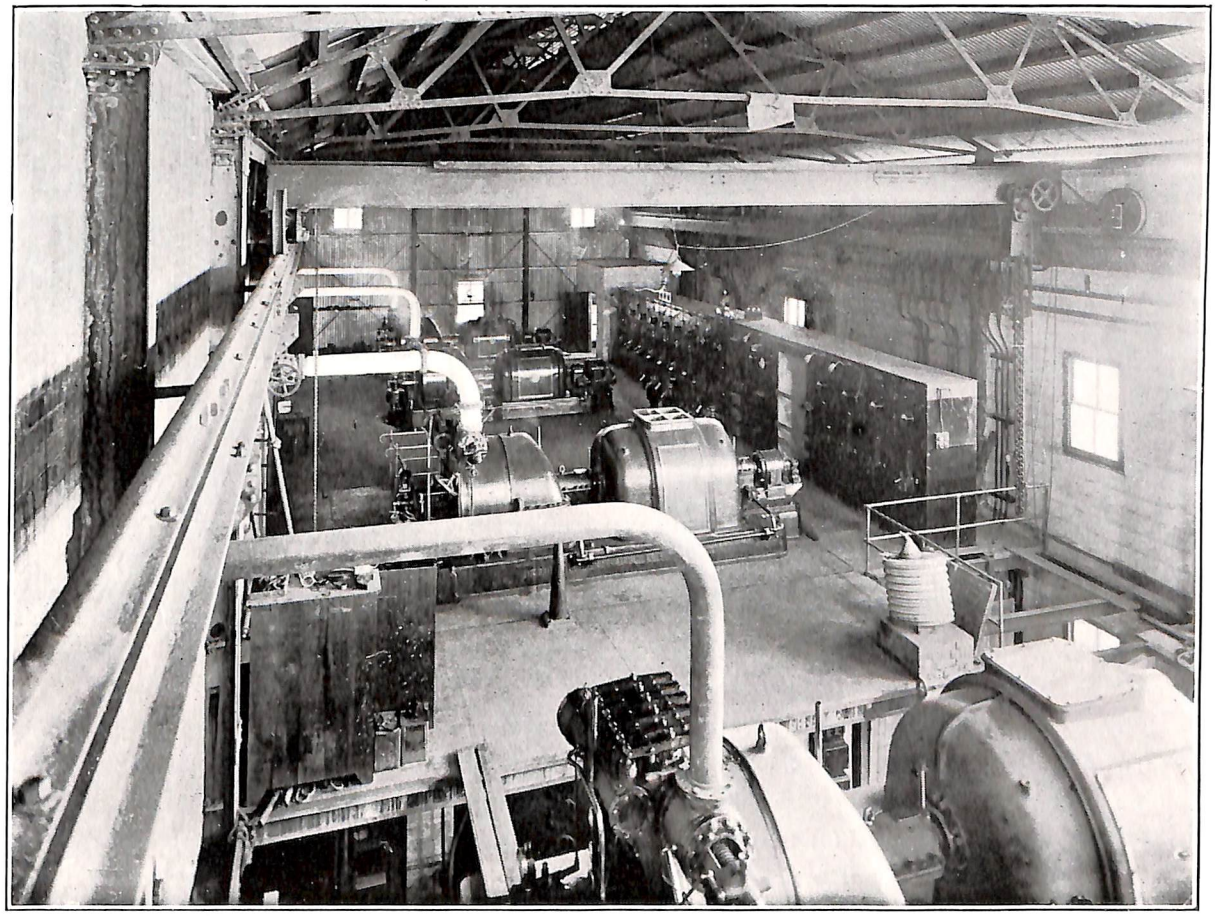
The Sprays.

catalytic action of Copper Oxide in a small attached electric furnace. Analysis is automatically made and recorded at two-minute intervals alternately for Carbon Dioxide and for combustible gas, plus Carbon Dioxide.

The vertical ordinates on the Chart give these values and enable the difference, that is the combustible gas percentage, to be read off in addition to the usual Carbon Dioxide record, the former indicating deficiency or otherwise of air, and the latter, completeness of combustion of the furnace gases.

TURBOS

Steam is generated at 200 lbs. pressure from the 23,000 square feet of heating surface, and is applied at 150 degrees superheat to four British-Thomson Houston Turbo Alternator Sets, two of 750 kilowatts and two of 1500 kilowatts. Three-phase, 50-cycle A.C. at 440 volts is given out from these units running at 3000 r.p.m. Feed-water is supplied to boilers by a Weir turbo feed pump at 8800 r.p.m., capable of delivering 8000 gallons per hour, more than equal to the capacity of the three vertical type reciprocating pumps, which are maintained for emergency.



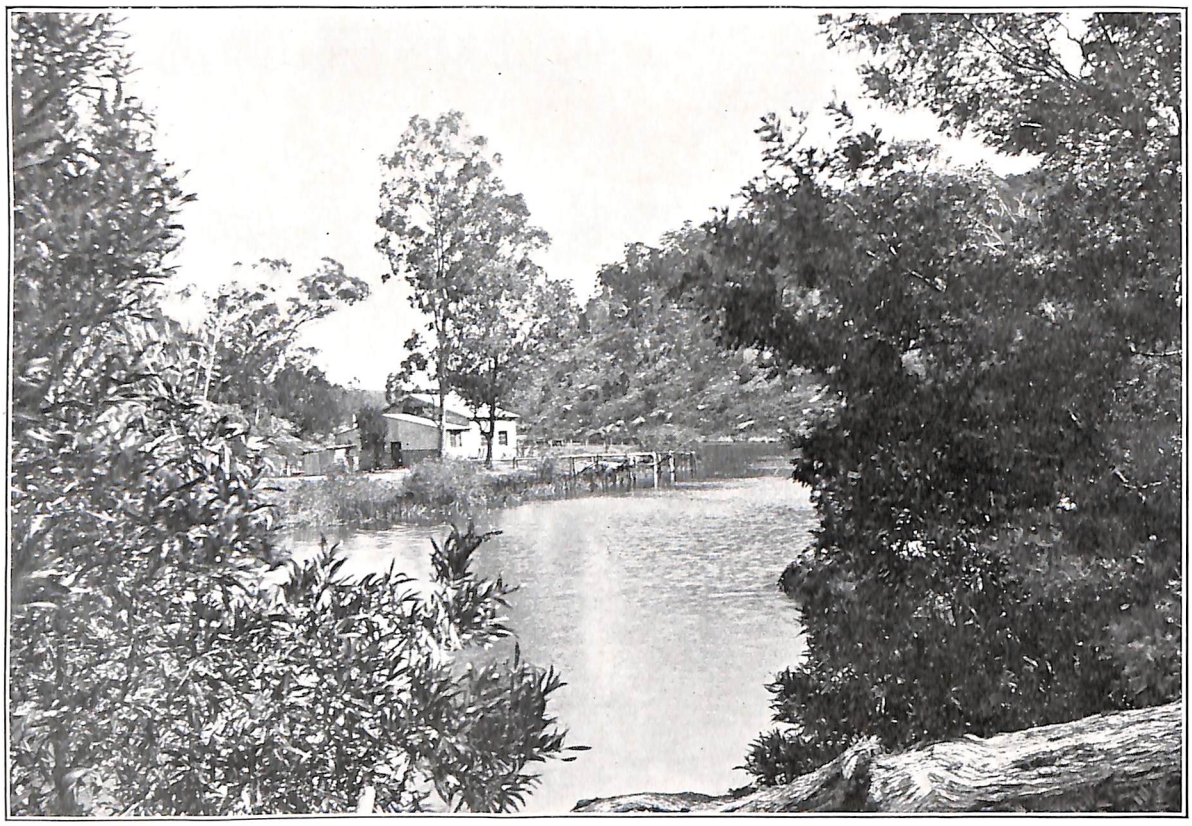
View of Turbines.

The Condenser Units are of the Contraflow type, fitted with Centrifugal Pumps and Steam Jet Extractors.

The condenser circulating water is cooled by a spray system, in which the temperature of the water being cooled is brought below 80 degrees Fahrenheit under the worst atmospheric conditions.

WATER SUPPLY

Ample supplies of water, equal in quality to that supplied to the City of Sydney, are obtained from the upper reaches of the Cudgegong River, where the Company has built a large weir.



The Pump House, on Cudgegong River.

The Pumping-house is situated below the weir, in which is installed an electrically-operated pump, the power for which is supplied from the Works Power Station through an overhead transmission line at 5000 volts. A stand-by pump, driven by a gas engine, is also installed for emergency.

The water is pumped to the works through an 8-inch pipe approximately 14 miles long.

TESTING

No description of the Kandos Cement Company's works would be complete without full reference to the Testing Department, which fulfils a vital function in the process of Cement making, and in this particular case is operated under conditions of equipment and organisation which are in accord with the general policy of thoroughness exhibited throughout the whole scheme of production.

The Laboratories are conveniently and adequately housed, and here the Works Chemists make periodical analyses of all the steps in manufacture, beginning with samples of the mixed raw materials—Limestone and Shale—as they leave the Raw Mills in the ground

condition. Hourly tests at this stage define the proportion of Shale and Limestone in the initial mixture, and also indicate fineness. These tests are checked again by samples at the Bins over the Kilns, to cover cumulative variations in the intervening conveying and storing system.

The Clinker from the Kilns is also sampled hourly and from these a composite sample is made up for the eight hours' run, giving the closest as well as the most comprehensive indications of the operating conditions. The finished ground Cement from the final grinding operation is also tested every hour for fineness, setting time and soundness, and from the hourly samples a daily composite sample is made up and completely analysed, and tested for fineness, tensile strength neat, and in a one to three mortar crushing strength in mortar, expansion during setting, and soundness.

A needle test is used to determine setting qualities, using a simpler variation on the Vicat instrument. Soundness is tested by boiling for a definite period, tensile and compressive strength by stressing to destruction in suitable machines, both of which are hand operated, convenient, and reliable.

Tests are taken after seven days and after twenty-eight days, and in addition an acceleration test, giving indication of twenty-eight-day results, is made after maintaining the briquette at 175 degrees Fahrenheit for seven days. The results obtained are uniform, and invariably in excess of specified requirements, due to the intrinsic quality of the Cement, and to experienced handling during manufacture.

Some attempt has been made to show that the significance of the Kandos Company's work lies not alone in the tremendous potentialities of the product which they are handling, but as well in the completeness with which every detail of production has been studied, and every section of the plant devised and arranged to handle large quantities quickly and continuously. The Company have appreciated this fact: That the speed, continuity and economy of each operation are secrets to its efficiency. Therefore, no effort or expense has been spared to secure the best men, the fastest and most reliable machines, the most advantageous lay-out both at the Quarry and the Works, and all possible assurances against interruption or break down. In adhering to this general policy a plant has developed which is unique in Australia, both as to the units in operation and the methods employed, and the existence of which, at this period, augurs well for the future of a most important national asset—the Cement Industry.

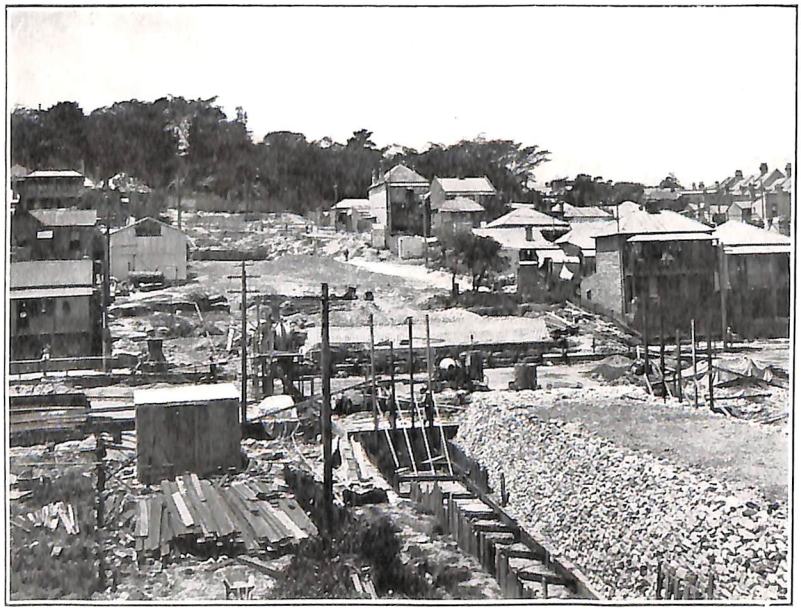
CONCRETE

The Ideal

Building Material

Notable Kandos Cement Concrete Works.

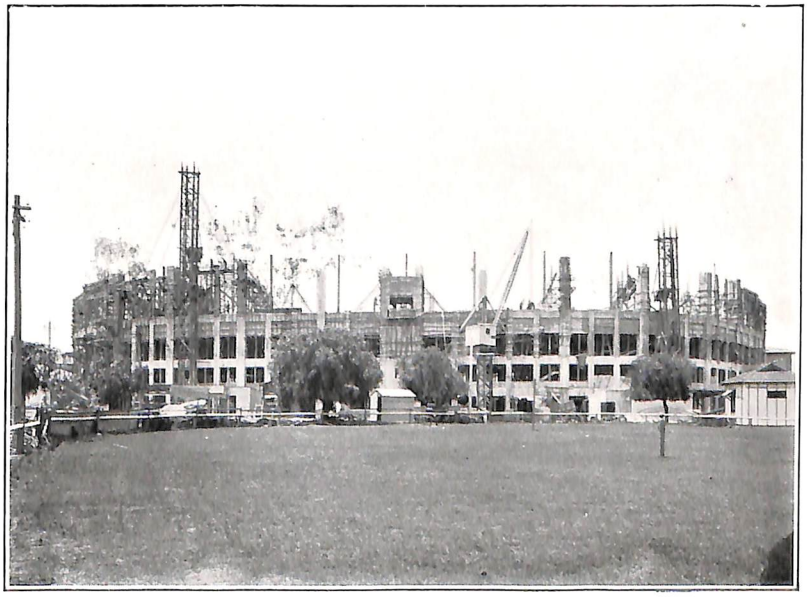
The Kembla Buildings, Margaret Street, Sydney, in process of erection for Messrs. C. H. Hoskins & Co. Ltd.



North Shore Bridge Railway Construction Works in progress at Bay Street, North Sydney.

"The Concrete Age"

Examples of Notable KANDOS Cement Concrete Works.

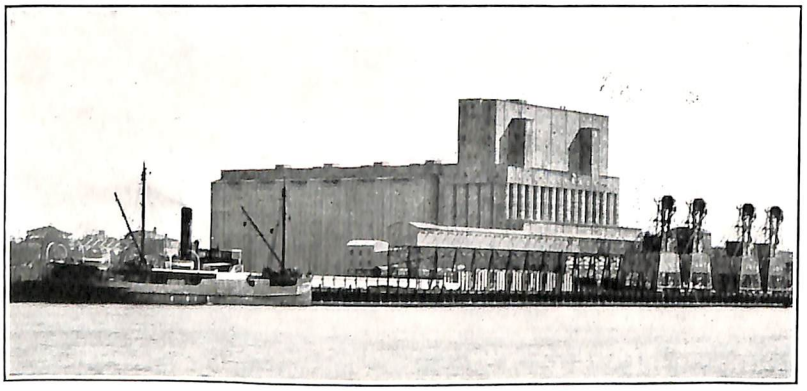


Above :
The Sydney City Railway Concrete Tunnel in Hyde Park

Left :
New Grandstand in course of erection at the Agricultural Showground, Sydney.

Concrete Road Making,
Botany Road, Sydney.
Kandos Cement is
being employed
in this work.

Concrete Wheat Silos at
Darling Harbour.
Kandos Cement used
throughout.



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Astor Flats, Macquarie Street, Sydney. A fine example of Modern Concrete Building. Kandos Cement used throughout.